Design Criteria

Vivarium

NIH Design Policy and Guidelines

D.1 Space Requirements

The space requirements for vivarium facilities vary greatly. Requirements are dependent on the specific use of the facility, the type and density of animals housed, the caging and racking systems, the number of investigators utilizing the facility, and the operational methodologies of the facilities. Each proposed facility will require careful analysis of the design team and consultation with users to determine adequate space requirements. For specific requirements refer to section E, Room Data Sheets.

D.1.1 Space Planning Criteria

Criteria for animal housing space are set forth in *The Guide.* The space requirements for a facility must consider the total animal population, the number of species, isolation requirements, the number of animals per room, and the number of investigators and research projects anticipated.

The assignment of support space is based on protocol, equipment, and process and can only be determined based on an evaluation of the specific project program of the facility users.

Application of these space criteria requires the design team to analyze functional requirements in light of specific project needs.

D.2 Gross Area Allowance/Grossing Factors

All space which is required for animal holding, animal support, office and office support, lab and lab support, and general building support space is considered net space or net assignable square footage. All other space, including space for wall thickness, corridors, toilets, mechanical and electrical spaces, etc., when added to the net area is classified as gross area.

Grossing factors will range from 2.0 to 2.2 times the net assignable area, largely dependent upon the selection of corridor and utilities distribution systems.

D.3 The Vivarium Module

Modular planning techniques have traditionally been employed to provide for an adaptable facility. Modular planning is based upon a concept of three-dimensional units of space and services which are used in a repetitive fashion for each type of function within the vivarium. The dimensions of the structural bay, both vertically and horizontally, must be carefully evaluated with respect to the laboratory planning module, mechanical distribution, and future expansion plans. The planning module must be developed based on an evaluation of operations and protocols and the anticipated animal populations.

In animal facilities, the most common unit of space is the animal housing/ holding room. The width of the animal room is determined by the number and types of animals, the way in which they are housed, and the cleaning methodology which will be employed. Room length is determined based on housing/caging options but also must accommodate service space for sinks, cleaning equipment, etc. The height of the animal room is primarily a function of the maximum rack height anticipated. There must also be enough space above the rack to provide a uniform airflow distribution in the room.

D.4 Circulation

D.4.1 Horizontal

Vivarium corridors should be 2,100 mm clear. Commonly accepted circulation systems include a single corridor, a dual corridor, or a single corridor with unidirectional flow. The NIH does not use the dual-corridor system. In a single-corridor scheme traffic is omnidirectional relative to the flow of cages between the animal room and the cage-wash area. The most significant advantage of a single-corridor system is its efficiency of space utilization. The disadvantage is the potential for cross contamination in the corridor when clean and soiled cages share space. Congestion caused by moving animals, cages, and supplies through a single corridor is also problematic. Corridors should be sized to accommodate the simultaneous passage of two racks (2,100 mm clear). However, contact between clean and dirty materials can be minimized by carefully scheduling pickups and deliveries, covering cages when moving them, and by using a unidirectional circulation system. With this management technique, congestion and contamination can be minimized.

D.4.2 Vertical

If animal facilities are provided in multilevel facilities, dual elevators (clean and dirty) should be provided. The elevator for transporting clean material should be located near the clean side of the cage-wash area, while the elevator used for soiled material should be in close proximity to the soiled side of the cage-wash area. The elevator location must consider cage and rack washing, storage, receiving, and waste removal, all driven by the number of cages, racks, and devices that must be washed, the frequency of the wash cycle, and the processing method.

Finishes of elevators must be cleanable and washable. The cab interior is to be totally stainless steel with durable nonskid surfaces on the floor. The cab interior shall have bumpers, sealed lighting, and sealed buttons.

The dirty elevator shaft is to have air pressure negative to all surrounding areas.

D.5 Furniture and Equipment

D.5.1 Casework

Cantilevered benchtops with rolling metal cabinets are preferred, because they allow for ease of cleaning.

Countertop materials will vary depending upon usage. Typically, chemical-resistant plastic laminates will be used. Epoxy resin will apply for most applications where corrosive chemicals are used or where sinks or heavy water usage occurs. Stainless steel should be used for radioisotopes, perchloric acid, glassware washing, cold rooms, and solvent usage.

D.5.2 Chemical Fume Hoods and Biological Safety Cabinets

Chemical fume hoods may be constant-volume or variable-volume exhaust hoods depending on user and facility management considerations of function, first cost, and life cycle cost issues. All containment devices must be located in the laboratory to avoid entrapment, blocking of egress, or posing a safety hazard to the lab occupant. All chemical fume hoods must conform to NIH Specification Sections #11800, 11810, 11820, and 11830.

Chemical fume hoods will operate continuously and must achieve a face velocity of 500 mm/sec with a uniform face velocity profile of +/-20% of the average velocity with the sash fully open. The bypass shall be designed so face velocity does not exceed the maximum as the sash is lowered. Chemical fume hoods must have a pressure-independent flow-monitoring device connected to a local audio alarm within the laboratory. Investigators should be consulted regarding sash preference. Combination sashes provide energy efficiency with the advantages of a vertical sash hood. Special hoods, such as canopy hoods, should be coordinated with the NIH Division of Safety.

Except for special hoods such as perchloric acid and radioisotope, chemical fume hood exhaust shall be combined with general laboratory exhaust.

BSCs are available in several classifications. Class II, Type A, and Class II, Type B1 or B2, will typically be government-furnished

equipment, supplied by the NIH. Class II, Type A, typically used at the NIH, is suitable for work with microbiological research in absence of volatile or toxic chemicals and is designed to recirculate HEPA-filtered air back into the laboratory. Class II, Type B1, exhausts most of the air to the exterior. Class II, Type B2, exhausts all of the contaminated air to the exterior. This type of BSC is not typically used at the NIH. NSF 49 and NIH Criteria and Standard Details regarding BSCs shall be used.

D.5.3 Equipment

A wide variety of equipment is utilized in NIH vivariums. The Design Architect/Planner/Engineer will plan the facility to accommodate current and anticipated equipment requirements. Equipment may include caging systems, sterilizers, cage washers, freezers, tables in procedure rooms, surgery and necropsy tables and related equipment, etc.

Washing and sterilizing equipment shall be steam powered. Requirements will be verified with users.

D.6 Architectural Finishes and Materials

Animal facility finishes must be strong and durable enough to meet the demands of cart traffic, frequent cleaning, and the use of high-pressure, high-temperature water, abrasives, and caustic cleaners, etc. All joints between dissimilar materials must be accessible, easily cleanable, and caulked.

D.6.1 Floors

Floors should be smooth, durable, moisture-proof, nonabsorbent, skidproof, and resistant to the adverse effects of disinfectants, high-temperature water, and detergent cleaning, as well as chemicals used in holding and procedure rooms and continuous movement of cages and equipment.

Resinous epoxy flooring, troweled, is recommended and offers the best protection. As other flooring systems become available, they should be analyzed for use. Floor covering should be carried up the walls to provide an integral covered base (at least 6 in. above the floor) for ease of cleaning. If thresholds are used, they must be of a type to permit the easy wheeling of cages or other equipment through the vivarium.

D.6.2 Walls

Walls must be free from cracks, unsealed penetrations, or imperfect junctions with ceilings and floors. They shall be constructed of materials capable of withstanding scrubbing with detergents and disinfectants and high-pressure water (in large-animal holding rooms), and be capable of withstanding the impact of cages, carts, and racks. Walls must also provide sound isolation (see section D.8 of the Reference Materials).

Ceramic tile and glazed block, although nonporous materials, are not recommended. The number of exposed joints increases both the possibility of failure and the opportunity for dirt to collect.

Concrete masonry units are effective for walls, but the porosity of the block must be overcome with the application of special coating systems. The joints must be tooled flush in order to avoid the collection of dirt. The block may be plastered, or a simple block filler can be used. After the block is filled, it can be treated with

at least two coats of high-grade epoxy paint.

Gypsum wallboard partitions shall not be ruled out as an acceptable wall type.

Bumper guards/rails on walls in corridors and animal holding rooms will prevent cages, racks, and handcarts from colliding with walls.

D.6.3 Ceilings

The ceiling must be smooth, moisture-proof, free from imperfect junctions with the wall, and capable of withstanding scrubbing with detergents, disinfectants, and water under pressure (in large animal rooms). Most ceilings may be constructed of moisture-resistant gypsum board. In most cases, a good priming agent and two coats of high-grade epoxy paint will be adequate. Monolithic ceilings such as gypsum board or sealed-plaster systems must be provided with corrosion-resistant access panels. In animal areas these panels are to be gasketed. Surface-mounted lights and exposed pipes are not permitted.

D.6.4 Windows and Window Treatment

Windows shall be nonoperable. Windows must be sealed and caulked. Treatments should meet all functional and aesthetic needs and standards. Light-tight treatments will be provided in all spaces that need to be darkened. Window systems shall use energy-efficient glass, and consistent visual appearance on the exterior of the building shall be considered. Security film should be used on all windows.

D.6.5 Doors

Doors should be sized to easily accommodate passage of cages, racks, and other equipment. Door size is minimum 1,100 mm wide and 2,100 mm high or as required for cage passage. Heavy (16 ga.) steel doors in steel frames are recommended. Door frames should be completely sealed with grout or other inert material to prevent harboring of pests. Doors should be sealed top and bottom and be provided with vision panels with light-tight covers, locks, kick plates, fixed bristle sweeps, and closers. Doors should be equipped with bumper rails. Doors shall comply with NIH Guidelines and

Standard Details. Vision panels should be provided in the active leaf of double doors

D.6.6 Door Hardware

The key system design shall be reviewed through the NIH Division of Security Operations, Crime Prevention Branch, Locksmith Unit. Such coordination is to be completed prior to submitting the hardware schedule to the Contracting Officer. The key and lock system shall be based on several levels of master keys. Grand masters and great-grand masters shall be provided for functional zones and modules. Master keys shall not be capable of opening pharmacies, computer areas, and medicine stations.

Room door-lock keys and day-lock combinations, where applicable, are special keys and shall not be mastered.

Doors to the exterior of the building that are also used as part of a means of egress (exit) will be readily operable from the inside of the building. When security devices are to be provided on egress doors, they are normally designed to unlatch upon loss of power (fail safe). In some buildings at the NIH, it is desirable to have the latching device to remain in place upon a power failure (fail secure). In either case, the determination of whether the device will be fail safe or fail secure will be made by the NIH Division of Security Operations and the NIH Division of Safety, Fire Prevention Section, with input from the clinical staff.

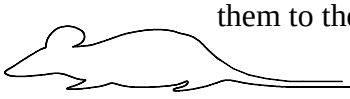
Any plan or specification for each new or modified door shall be submitted to the following:

Division of Security Operations, Crime Prevention Branch
Room B3B16, Building 31
Phone (301) 496-9818

and:

Division of Safety, EM Branch, Fire Prevention Section
Building 15G-2
Phone (301) 496-0487

Keys are to be turned over to the Project Officer, who will give them to the Locksmith Unit.



D.7 Structural

D.7.1 Vibration

An analysis of vibration response of the structure shall be made. Consideration must be given to vibration of floor-framing systems caused by mechanical and electrical equipment such as pumps, chillers, fans, emergency generators, and transformers and other sources such as foot traffic, parking garage traffic, and movement of heavy equipment.

Many animals are extremely sensitive to vibration, and it can produce detrimental effects on research. Designers must take every opportunity to control vibration and to locate vibration sources away from animals and activities sensitive to vibration. Specific vibration recommendations shall be made by an experienced vibration consultant. Steel structures shall not be precluded for use in structural design relative to vibration without analysis.

To control vibration transmitted into vivarium space, the Architect/ Engineer shall consider the following items during the early design phases:

The structural system should be relatively stiff so that any vibration that is transmitted occurs at high frequencies. Vibrations occurring at higher frequencies are more easily dampened with instrumentation vibration-dampening systems and isolation tables than vibrations occurring at lower frequencies.

The structural system should have relatively short column spacing.

Vivarium spaces should be located from sources of vibration.

Vivarium facilities should be located on grade-supported slabs. This not only reduces vibration concerns, but pits required for cage and rack processing are more easily accommodated and the risk of water leakage to lower levels is eliminated.

On framed floors, corridors and vivarium spaces should not be combined in the same structural bay.

D.7.2 Module/Bay Size

The dimension of the structural bay, both vertical and horizontal, must be carefully evaluated with respect to the functional requirements of vivarium spaces, the primary building module, mechanical distribution, and future expansion plans.

The horizontal dimension of the structural bay must be a multiple of the planning module or primary building module dimension for maximum flexibility and to allow uniform points of connection for vivarium services.

Columns must not fall within the vivarium-planning module or building module to prevent interference with vivarium space planning and cause inefficient use of vivarium space.

Close coordination between structural and mechanical disciplines is critical to minimize interference of piping and ventilating systems with the structural framing.

D.7.3 Floor Slab Depressions

Floor depressions and/or topping slabs will be evaluated for use in special-finish areas, wet areas, or areas exposed to materials that may deteriorate the structural floor slab. Floor depressions shall be reviewed for equipment requirements to allow for ease of movement of equipment. Floor slabs shall slope to accommodate drainage, and pits shall be provided in cage-wash areas. Suitable protection of the concrete and reinforcing shall be considered in high-temperature cage-wash areas.

D.7.4 Equipment Pathway

The potential routing or pathway for the addition or relocation of heavy equipment shall be reviewed and identified during the design phase.

D.8 Heating, Ventilation, and Air Conditioning (HVAC)

HVAC systems must meet the requirements published in *The Guide for the Use of Laboratory Animals*. Temperature, humidity, and air-change rate must be carefully controlled and monitored on a continuous basis. Systems must have adequate ventilation capacity to control fumes, odors, and airborne contaminants and offset the heat load of lab animals.

HVAC systems must be both reliable and redundant and operate without interruption. There should be no exceptions. HVAC systems must be designed to maintain relative pressure differentials between spaces and must be efficient to operate, both in terms of energy consumption and from a maintenance perspective. Federal Energy Standards, to the extent possible, must be achieved. An energy-monitoring control system shall be provided. Studies shall be conducted during the design phase to determine the feasibility of utilizing heat-recovery systems in vivarium buildings.

Principal design guidelines include control of contamination, prevention of cross contamination, temperature and humidity control, energy conservation, and reliable operation.

D.8.1 Building Design Considerations

The Project Engineer shall include at the completion of the schematic design phase a Basis of Design report. The report shall be a bound presentation with documentation sufficiently complete to justify the complete design concept of the Architect/Engineer. Detailed building design criteria, computations, schematic system diagrams, economic analysis, and life cycle costing comparisons shall be included as a part of the Basis of Design report.

D.8.2 Energy Conservation

The Building Officials and Code Administrators, International (BOCA) National Energy Conservation Code shall be utilized to regulate the design and construction of the exterior envelopes and selection of HVAC, service water heating, electrical distribution, lighting systems, and equipment required for the purpose of effective use of energy and shall govern all buildings and structures erected for human occupancy. When requirements of the energy conservation code cannot be satisfied because of program

requirements, the NIH Project Officer shall be notified.

At the completion of the design development phase, a plan review record as defined in the BOCA National Energy Conservation Code shall be submitted stamped and signed by a licensed professional engineer showing full compliance with the code.

Minimum system insulation thicknesses shall be as required by the energy conservation code and American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommendations. The minimum thickness in all applications shall be sufficient to prevent condensation.

The quality of the building environment shall be supportive of the health and safety of staff and patients. Opportunities for conserving energy resources shall not compromise staff or patient health and safety nor hinder continuous research functions.

Effective energy management requires close, consistent control of all energy consuming systems and components. Evaluations shall be compared to systems employing no heat recovery or energy conservation components. The capital cost, energy cost, maintenance cost, and payback period of the heat reclamation systems shall be evaluated for the use at the NIH.

D.8.3 Systems Economic Analysis

The purpose of the economic analysis is to determine the comparative life cycle costs of various HVAC system alternatives. The analysis shall provide sufficient data to indicate the most economical and energy-efficient system and to permit a comprehensive review of all computations. The analysis shall include and compare total initial capital cost, energy cost, operating cost, system reliability, flexibility, and adaptability for each alternative. Each system alternative considered shall satisfy completely the program requirements as to flexibility, redundancy, reliability, and ease of maintenance. The total capital cost to provide the program requirements for each alternative shall be included as part of the life cycle cost.

D.8.4 Outdoor Design Conditions for the NIH, Bethesda

For facilities whose purpose is animal research and for HVAC systems requiring 100% outside air, outdoor design conditions shall be as follows:

Summer:	35^{o}C dry bulb and 20^{o}C wet bulb, 12 km/h wind
Winter:	23^{o}C dry bulb, 24 km/h wind
Latitude:	39 N, daily temperature range: -8^{o}C

For all other facilities such as office buildings, administrative facilities and noncritical HVAC Systems not requiring 100% outdoor air, the values recommended by current ASHRAE *Handbook of Fundamentals* shall conform with the following:

Summer	1% design dry bulb 1% design wet bulb
Winter	99% design dry bulb

The design wet-bulb temperature for sizing cooling towers shall be 1 degree higher than the ASHRAE 1% outdoor design wet-bulb temperature.

All outdoor air-cooled condensing equipment shall be designed and selected based on a 41^{o}C ambient temperature.

D.8.5 Indoor Design Conditions

The following indoor design conditions shall be used in the design of the animal facilities. Animal-holding areas shall be maintained at the design conditions at all times. Design conditions shall be satisfied under all load conditions between the various holding areas.

<u>General Requirements:</u>

	Temperature	Humidity
Summer	23^{o} C +/- 1^{o}C	50% +/- 5% relative humidity (RH)
Winter	23^{o}C +/- 1^{o}C	40% +/- 5% RH

Animal Housing:

	Temperature	Humidity
Mouse	18°C to 26°C	40-70% RH
Hamster	18°C to 26°C	40-70% RH
Guinea pig	18°C to 26°C	40-70% RH
Rabbit	16°C to 21°C	40-70% RH
Dog	18°C to 29°C	30-70% RH
Nonhuman primate	16°C to 29°C	45-70% RH
Chicken	16°C to 27°C	45-70% RH

Ideally, all animal-holding rooms shall be capable of housing all species to be housed. The HVAC system must also be capable of maintaining the full range of requirements for all anticipated animal populations.

The temperature range required to accommodate most commonly used research animals is 18°C to 29°C controlled to plus or minus 2°C. The ranges do not represent acceptable fluctuation ranges. The humidity must be between 30% and 70% and normally controlled to 50% plus or minus 5%. These ranges can be narrowed when the species anticipated have similar requirements.

Some laboratories within the vivarium conduct special research requiring unique temperature and humidity ranges and control. These special cases must be evaluated and provided for on a case-by-case basis. The HVAC system must be designed to accommodate these unique conditions as they occur.

D.8.6 Air Quality

HVAC systems for vivarium facilities must be independent from other building HVAC systems. These systems must maintain a safe and comfortable environment for animals, be adaptable, and be capable of maintaining environmental conditions in any of the holding rooms for any of the species anticipated to be housed in the facility.

Since most animal studies are of long duration, they must be performed under consistent conditions in order to achieve repeatable results. Thus, the failure of the HVAC system is

unacceptable. Therefore, the HVAC system must be designed to provide backup in the event of component failure. Central HVAC systems thus should be provided with multiple chillers, pumps, cooling towers, etc. to improve reliability.

Some rooms may be designated as "hooded rack" type rooms having a housing chamber with sash fronts similar to a walk-in fume hood or individual air recycle systems of the laminar-flow type. Unit directional flow, laminar-flow type systems for any of the rooms may also be required.

With regard to ventilation, the following objectives should be considered: the elimination of drafts which could adversely affect animal health; monitoring, maintaining, and recording consistent temperature and humidity conditions in individual rooms; and controlling the airborne animal hair and particulate count.

The minimum ventilation rate for animal housing and treatment facilities shall be 15 air changes per hour with loaded filters. Recirculation of air in a vivarium is prohibited. The air-conditioning flow rate for an animal room shall be determined based on the following factors:

- The desired animal microenvironment
- The species of animal(s) and their population
- The required minimum ventilation rate
- Internal loads within animal room
- The recommended ambient temperature and humidity
- Heat gain by the animals

The Architect/Engineer shall consider additional factors, such as the method of animal cage ventilation, the operational use of a fume hood or a BSC during procedures involving animal cage cleaning and animal examinations, airborne contaminants, and institutional animal care standards, in the *Design of Human Facilities.*

In addition to the prefiltration normally used, additional filtration is generally provided with efficiencies ranging from 95% to

99.99% (HEPA). This final filtration is to protect against particulate and other contaminants which the air-handling equipment itself can generate. The Design Engineer shall review the specific Program of Requirements to establish specific filtration criteria.

D.8.7 Air Motion Criteria

Animal facilities shall be designed with special attention to air quality, acoustics, airflow quantities, diffusion characteristics, means of delivery, delivery temperature, air velocity, and air distribution.

- Distribution shall prevent cross contamination between individual spaces, air shall flow from areas of least to areas of higher contamination potential, i.e, from "clean" to "dirty" areas.

- Air supply terminals shall be located at ceiling level or close to ceiling level if located on side walls. Exhaust from animal rooms shall be located near the floor level. It is preferable to have multiple exhaust points in animal rooms.

- Air distribution and diffusion devices shall be selected to minimize temperature differentials in the space. The maximum air velocities in the occupied zone shall not exceed 0.25 m/s at an elevation of 1.8 m.

- In the cage-wash facility, the dirty, clean, and cage-wash equipment, including associated mechanical supporting equipment areas, shall be physically separated from each other, including equipment pits. Canopy exhaust hoods shall be installed for heat-generating cage-wash equipment in both the dirty and the clean side of the facility.

D.8.8 Relative Pressurization

Vivarium spaces must be protected against contamination from outside sources, including particulates brought in from outside in the HVAC airstream. Generally the vivarium facility must remain at a negative air pressure relative to clean corridors and other nonvivarium spaces but positive with respect to the outside

environment. Relative pressurization inside the vivarium facility is a series of complex relationships. Some of these relationships may change as research and animal populations change. The HVAC system must be capable of maintaining these relative pressure relationships and capable of adapting as facility utilization changes.

Clean areas of the facility, including the clean side of cage and rack washing, the clean corridor system, and bedding dispensing, diet, and preparation areas must be positive relative to animal holding areas or soiled areas.

Animal housing areas generally are negative relative to clean areas and positive relative to service corridor and soiled areas.

Soiled areas such as the service corridor, the soiled side of cage and rack washing, and decontamination and waste-holding areas must be maintained at a negative pressure relative to the animal rooms.

Some areas have special pressurization requirements and shall be addressed individually.

Animal-holding areas for transgenic or immunosuppressed populations must be maintained at a positive pressure and may require special filtration of supply air.

Potentially infectious populations must be maintained at a negative pressure to prevent contagion from migrating to other populations. Depending on the nature of the infectious agents involved in the research, these areas may be required to meet the design criteria for biohazard containment facilities. To maintain these special conditions, anterooms or micro-isolator housing units may be required.

The pressure relationships for animal care areas including treatment rooms, procedure rooms, necropsy rooms, and surgical areas require investigation by the design team with the facility user to determine project-specific requirements.

The HVAC system must be adaptable so that pressure relationships can be modified as required over the life of the facility.

D.8.9 Heating and Cooling Load Calculations

Complete design load calculations and a vapor drive study shall be prepared for each space within a design program and presented in a similar format to that outlined in the latest ASHRAE *Handbook of Fundamentals.* Heating and cooling load calculations are required for all projects to facilitate review and provide a reference for system modifications. Individual room calculations shall be generated and summarized on a system basis and presented with a block load to define the peak system load. Load summary sheets shall indicate individual rooms with area, design air quantity, liters per second per square meter, air changes per hour, and corresponding return or exhaust air quantity. Calculations shall include but not be limited to indoor and outdoor design parameters, heat gains and heat losses, supply and exhaust requirements for central systems and for each area of the facility, humidification and dehumidification requirements, and heat recovery. As a reference, calculations for assessing heating and cooling loads may include but are not limited to the following:

Sensible Heat Loads:
Windows, solar/conduction components
Walls, external, external chases
Roofs and skylights
Floors, when above unconditioned spaces
Ceilings, when below unconditioned spaces
Partition, when next to unconditioned spaces
People, sensible
Animals, sensible
Lights, room, and task
Internal equipment and personal computers
Supply, return, and exhaust fan heat
Infiltration
Makeup and ventilation air requirements
Auxiliary air requirement

Latent Heat Loads:
People, animals, internal equipment
Infiltration
Makeup and ventilation air requirements
Auxiliary air requirements

All heating and cooling load calculations shall include a predetermined safety factor to compensate for load inaccuracies, future flexibility, infiltration, and air leakage. Safety factors shall be clearly defined in the Basis of Design report.

D.8.10 Building Solar and Conduction Loads

The Design Engineer shall provide a thorough review of all building construction components to accurately calculate the resultant R and U values for the various construction conditions. Calculations shall include a sketch of the construction conditions and include a written description of where the conditions exist. Component R values used shall be referenced as to their source and where possible tied to project specification. R and U values, shading coefficients, vapor transmission values, transmittance, doors, windows, and skylights shall be selected by the Architect/ Engineer and accurately defined in the project specification.

D.8.11 Lighting Loads

The HVAC system shall provide as a minimum capacity for the following heat loads generated by room and task lighting:

Animal Holding Areas:
Task lighting: 250 W/person
Room lighting: 32 W/nm2

Offices:
Task lighting: 250 W/person
Room lighting: 32 W/nm^2

Corridors:
General lighting: 11 W/nm^2

D.8.12 Occupant Load

One person per 100 nm^2 of vivarium space.

D.8.13 Animal Room Heat Loads

ASHRAE data concerning animal heat loads and NIH estimates concerning animal room occupancy shall be used for system design.

Heat Generated by Laboratory Animals:

Species	Weight Grams	Heat Generation: Normally Active (Watts per animal) Sensible	Latent	Total
Mouse	21	0.33	0.16	0.49
Hamster	118	1.2	0.58	1.78
Rat	281	2.3	1.1	3.4
Guinea pig	409	3.0	1.5	4.5
Rabbit	2,456	11.5	5.7	17.2
Cat	3,000	13.4	6.6	20.0
Nonhuman Primate	5,448	20.9	10.3	31.2
Dog	1,031	30.8	16.5	47.3
Dog	22,700	67.7	36.0	103.7

A typical 3 m x 7 m animal holding module will have the following species density:

Animal	Animals per Rack	Racks per Module	Animals per Module
Mouse	300	5	1,500
Rat	90	5	450
Guinea pig	40	5	200
Rabbit	8	5	40
Cat	8	5	40
Primate	8	5	40

D.9 Plumbing

Types of plumbing systems in the vivarium may include wash systems, waste drainage systems, animal drinking water systems, and medical gas systems. Plumbing systems specifically installed for animal support require close review with an animal care specialist to determine the exact feature designs.

Guidelines for vivarium plumbing system design must carefully minimize the potential for accumulating dirt and providing pest harborage and access to animal care areas and so that all pipes, mounting brackets, supports, et cetera are caulked and sealed during installation. Some general criteria that should apply include: minimizing any exposed piping inside animal rooms; installing piping with standoff support to aid in proper cleaning; avoiding insulation of pipes; minimizing pipe penetrations, with any penetrations being carefully sealed; and evaluating pipe materials that do not use toxic-releasing compounds during manufacturing. Careful consideration must be given to drainage facilities as waste lines frequently become clogged.

Large quantities of liquid waste leave the vivarium through the sewer systems. As such, the system must be adequately sized, particularly if it is mixed with feces and bedding. A 150 mm waste line is generally recommended for animal rooms. Floor or trench drains with automatic water system for maintenance should be considered when animal holding rooms are used in large animal rooms only.

Disposal of solid waste in the form of bedding, paper, feces, animal carcasses, and other miscellaneous wastes must also be carefully considered. Bedding can be disposed of by a mechanical slurry system contained in a cage wash. This later procedure reduces labor and the volume of solid waste.

D.10 Electrical

D.10.1 Normal Power

The following load figures in voltamperes per square meter shall be used in sizing the overall building service. These figures are connected load and should be used in the early design stages. Actual design loads shall be used in the later part of the design. The range provided is to allow for varying intensity of usage. The mechanical loads do not include chilled water or steam generation, which are produced centrally on the NIH campus. The Engineer shall use sound judgment in applying these numbers.

Load	VA/m^2
Lighting	27 - 38
Receptacles	22 - 43
HVAC	97 - 108
Lab Equipment	43 - 86
Elevators	11 - 16
Miscellaneous	11 - 22
Total Range	211 - 313

Conduits in vivariums shall be concealed. Surface-mounted conduits in washdown areas shall be IMC or rigid galvanized steel with threaded couplings. Conduits in vivarium areas shall be sealed with conduit sealer such as Duxseal at each device/junction box. Surface metal boxes shall be cast metal. Conduits entering or leaving device boxes, junction boxes, pull boxes, etc. shall be sealed at each box with a nonhardening sealant such as Duxseal. An alternative is to use seal-off fittings in conduits penetrating vivarium walls. A potting compound shall be poured into the fitting after the wires are installed.

Surface metal raceway with snap-on covers shall not be used in vivariums due to the requirements for washdown cleaning.

Operating rooms associated with vivariums shall have isolated power panels with ungrounded secondaries and line isolation monitors. Branch circuits in operating rooms shall have type

XHHW insulation and #10 AWG ground conductors. Isolated power branch circuits shall have conductors with orange- and brown-color XHHW insulation to reduce leakage current.

D.10.2 Emergency Power

The following load figures in watts per square meter shall be used in sizing the generator. These figures are connected load and should be used in the early design stages. Actual design loads shall be used in the later part of the design. The range provided is to allow for varying intensity of usage. The Engineer shall use sound judgment in applying these numbers.

Load	W/m^2
Lighting	1- 5
Receptacles	1- 2
HVAC*	1- 32
Lab equipment	20 - 43
Elevators**	2 - 2
Total range	25 - 84

* Supply and exhaust fans for animal holding
** Minimum: one elevator per bank of elevators

The following loads are required to be connected to emergency power. These loads are in addition to any code required emergency loads:

- Operating rooms
- Animal ventilation fans
- Ventilated animal cages and cage systems
- CCTV cameras and equipment
- Security system
- Switch controlled minimal lighting in animal holding rooms

D.10.3 Lighting

The lighting levels listed below in lux shall be used for design purposes. The values listed are average maintained illuminance levels using a total maintenance factor of 75%. The numbers listed are target values and shall be adjusted to meet the research requirements.

Function/Space	Lux
Vivariums	270 - 800 variable through dimming
Offices	525 - 800
Corridors	325 - 525
Stairwells	200 - 325
General storage	200 - 325
Mechanical/electrical room	200 - 425
Cage wash	325 - 525

Areas not identified above shall use Illuminating Engineering Society of North America (IESNA), *Lighting Handbook*, for recommended values.

Lighting in vivariums shall be dimmable and shall have time of day automatic control where required for controlled environment studies.

Industrial fluorescent lighting fixtures shall have a wire guard or plastic sleeves over the lamps.

D.10.4 Security

Vivariums require strict access control. A card system exists on campus for building access. The Division of Security Operations (DSO) shall be notified during the early stages of design for card access approval.

D.10.5 Fire Alarm

A fire alarm voice communication system shall be provided in the animal holding/procedure areas. Upon an alarm, the fire alarm speakers are to sound a "slop whoop" signal, at 90-110 dB, for one cycle (4.1 seconds), followed by a repeated voice evacuation message. The voice message shall continue until the fire alarm control panel is reset or the "alarm silence" switch is activated. Refer to Section D.15, Fire Safety/Fire Protection.

D.11 General Health and Safety

The NIH, through the Division of Safety, has developed a comprehensive Occupational Safety and Health program to protect the safety and health of all employees at the campus. This includes the occupational work setting found in laboratories, clinical settings, animal-handling activities, and mechanical support services.

Safety and health regulations and guidelines require the use of engineering controls for worker protection, wherever possible, to minimize the potential for occupational exposure to hazards in the workplace. To be most effective, engineering controls for protecting occupational safety and health must be designed into facilities for both new construction and renovated space. This proactive approach can minimize numerous common potential health and safety concerns in vivarium facilities.

These health and safety guidelines are to be incorporated**,** as appropriate**,** in facility-specific construction documents by the Architect/Engineer to ensure that health and safety protection is engineered into the design of any new or renovated facility.

While many of the requirements for health and safety engineering are incorporated in these guidelines, it is impossible to cover all possible concerns. The architectural/engineering firm should, whenever possible, have a health and safety specialist on staff and should always consult with Division of Safety personnel with regard to specific health and safety engineering requirements in the design of new construction and renovation projects.

D.11.1 Physical Hazards

Animal-holding areas shall be designed with employee movement requirements in mind. Specifications for vivarium equipment should include a requirement that, whenever possible, sharp edges and other protuberances that may cause injury to either personnel or animals should be avoided.

The location, height, weight, and ergonomic problems of cages hanging on walls must be considered in the design in order to

minimize employee hazards associated with lifting and removing these large objects.

Due to the frequent washing/wetting down of surfaces, floor areas should be slightly sloped to drain to reduce pooling of water and the probability of slips and falls.

Because of the potential for wet environmental surfaces in the vivarium**,** all electrical systems and apparatus must be connected to a ground fault circuit interrupter (GFCI) to prevent electrical shock in accordance with 29 CFR 1910, Subpart S requirements. Refer to the Electrical section of these guidelines for the discussion on shunt trip breakers and GFCIs.

D.11.2 Emergency Safety Equipment

Where potentially hazardous chemicals and cleaners are in use (e.g., cage washing areas, etc.), eyewash stations and safety showers are required. These must be designed and installed in accordance with American National Standard Institute (ANSI) Standards. Eyewash stations should be available within 25 meters of the site of chemical usage. In addition, any room equipped with a chemical fume hood shall have an eyewash station and safety shower.

D.11.3 Gas Cylinders

Where appropriate, gas cylinders should be placed outside the animal area with piping and wall valves to access the gas(es). Therefore, an area to place, secure, access, and remove the cylinders must be designed in a service corridor or outside the building. Anesthesia gases for surgical purposes may be required at the site of use. Architects/Engineer should consult with vivarium personnel to determine the preference of the user.

D.11.4 Waste Storage

The waste storage area must be located on the “dirty” side of the facility. This area must be sufficiently large for the storage of waste materials generated in the facility. This location should be near exit doors and should provide sufficient room to facilitate movement of waste containers/carts in a safe manner, with minimal

ergonomic stress.

The waste storage area must be caulked and sealed to minimize pest harborage and promote proper cleaning.

D.12 Biosafety

Major biosafety concerns for animal facilities include ventilation for animal welfare, sanitation, and containment of animal dander and odors and infectious agents. Clean/dirty corridor designs are recommended with directional airflow and minimal pressure differentials from clean to dirty areas.

D.12.1 Biosafety Level 2 Facilities

All animal facilities should be designed and built to conform with biosafety level C (BL-2) requirements. These requirements include the following:

Housekeeping/Maintenance: All animal rooms and adjacent facilities are to be constructed so as to facilitate proper cleaning and housekeeping and to minimize pest harborage.

Sinks: A handwashing sink must be placed in rooms where infected animals are to be housed.

Windows: Animal facilities should be designed without windows. However, windows, where present, must be designed not to open. All interior windowsills must be sloped, and seams around windows as well as other seams in the laboratory must be sealed to ensure ease of cleaning and decontamination.

Floor Drain: Floor drains are not essential in all animal rooms (the Architect/Engineer should review the need for floor drains with vivarium and safety personnel). Where necessary, floor drains must be capable of being capped off and sealed when not in use and when potentially hazardous materials that should not be released to drain are being used.

HVAC/Exhaust: Exhaust from animal rooms must be discharged to the outside with no recirculation of air to other rooms. For protection of personnel and to minimize the potential for cross contamination of animals, the direction of airflow must be inward to the animal rooms at all times. Where protection of the animals from possible contamination is important, consideration should be made of providing ventilated airlocks for the animal rooms. The

use of filtered isolation cages may also be considered. Architect/ Engineers should consult with vivarium personnel with regard to the specific requirements for protection of animals.

Autoclaves: Space for autoclave capacity must be provided on the "dirty" side of the facility for decontamination of cages, waste materials, and other contaminated equipment. The autoclave provided may be a double door/pass through. The doors should be interlocked to prevent the possibility of contamination of the "clean" side.

Space should also be considered for "clean" autoclaves (for sterilization of microbiological media, and clean instruments, etc.) when required by vivarium personnel.

D.12.2 Biosafety Level 3 Facilities

BL3 animal facilities must be designed for the containment of indigenous or exotic agents which have potential for respiratory transmission, which may cause serious and potentially lethal infections in personnel, and which can be spread to the community through release to the environment.

The following requirements must be met in the design of BL3 containment facilities

Restricted Access: BL3 animal facilities must be separated from other animal facilities and work areas by passage through two sets of "self-closing" doors. There must be a ventilated airlock designed to separate the common corridor(s) from the BL3 containment animal facility.

The purpose of a BL3 animal facility is to ensure containment of agents used in the facility. It is recommended that airlock doors be interlocked to prevent simultaneous opening of doors between outside corridor and containment areas. Interlocks, when present, should be provided with a manual override for use in case of emergency. Final determination on the design of airlocks for these facilities should be made in consultation with safety personnel.

Windows: Animal facilities should be designed without windows. However, windows, where present, must be designed not to open. All windowsills must be slanted, and seams around windows must be sealed as with other seams in the laboratory to ensure ease of cleaning and decontamination.

Interior surfaces: Interior surfaces of walls, floors, and ceilings must be water resistant (i.e., epoxy paint, caulking, etc.), gas tight, and easily cleanable.

Integrity of BL3 Space: All electrical and plumbing conduits and supply and exhaust ducts must be sealed at the point of penetration into the facility to ensure containment and to ensure the capability for gas decontamination.

All penetrations in walls, floors, and ceilings must be sealed (with a smooth finish) to facilitate decontamination and cleaning. All joints between fixed cabinetry (e.g., shelves, cabinets, plumbing fixtures, etc.) and the floor or wall must be smooth coved and sealed to ensure maximum cleanability.

In all new construction, all access to critical mechanical equipment (ventilation ducts, fans, piping, etc.) must be provided outside of the containment facility. No compromise of the integrity of the containment of the BL3 animal facility is allowed.

When retrofitting existing animal space as BL3 containment, it may not be possible to keep access to critical mechanical equipment outside of the space. In these cases, an access panel must be supplied inside the laboratory to allow access to such mechanical equipment. The access panel must be hinged with a (piano-type hinge) and gasketed with gas-tight gaskets to ensure an appropriate seal for both containment and decontamination procedures.

Handwashing Sinks: A sink for handwashing is to be located near the exit door of each BL3 laboratory (not in the airlock). Sink faucets must be foot, elbow, or automatically operated.

HVAC/Exhaust: Ventilation must be single-pass air, and all BL3 space must be kept negative with respect to outside corridors and laboratories. Exhaust ducts must be under negative pressure until discharged outside the building.

Supply and exhaust ducts for BL3 animal facilities must be supplied with gas-tight dampers to ensure the capability of gas decontamination of the facility without compromising the rest of the building.

While HEPA filtration of room exhaust from BL3 animal facilities is not always necessary, an evaluation of the need for specific filtration should be performed during the initial planning and design stages of the project. User groups and personnel of the NIH Division of Safety must be consulted. Safety personnel will determine the need for such filtration.

The exhaust from an autoclave contains a significant amount of moisture. Filtration of this exhaust, when necessary, must be through a moisture-resistant (hydrophobic) filter such as a Pall 0.2 micron filter or the equivalent.

Vacuum Systems: Vacuum systems in BL3 animal facilities must be protected by filtration. (See requirements in the Vacuum Systems, section D.17.7 of the Reference Materials).

Alarms: BL3 facilities must be alarmed to indicate a failure to maintain a negative pressure differential from a noncontaminated area to potentially contaminated areas. Both visual (gauges) and audible alarms are necessary. All alarm systems must be validated prior to occupancy of the containment space by research personnel.

Biological Safety Cabinets/Containment Equipment: Appropriate biological safety cabinets and other containment equipment must be provided as necessary for the work to be performed. The determination of appropriate equipment needs should be made in consultation with user groups and NIH Division of Safety personnel during the design phase of the project.

Autoclaves: An autoclave for decontamination of waste from the BL3 animal rooms must be available in the facility, preferably within the BL3 suite.

D.13 Radiation Safety

Work performed at the NIH animal facilities involves the potential for occupational exposure to radioactive materials and other sources of ionizing and nonionizing radiation. While the procedures identified as good radiation safety (health physics) practices and techniques are essential to minimize potential exposure to radiation; security, containment, and shielding of this material and equipment through the use of good facility design are extremely important elements. In addition to the protection of occupationally exposed workers, the NIH Division of Safety, Radiation Safety Branch, has to ensure that the general public and surrounding environs are also provided with an adequate and similar degree of protection.

The intent of this section is to provide Architects/Engineers and construction contractors with a working knowledge of the facility design parameters required for the construction of facilities which must provide for the control and containment of radiation hazards.

Not all sources of ionizing radiation are covered by Nuclear Regulatory Commission (NRC) licensing. These nonlicensed sources are, however, controlled by regulations issued by the NIH Radiation Safety Committee upon recommendation by the Radiation Safety Officer. Nonlicensed sources include X-ray machines, high-voltage accelerators, electron microscopes, and radioactive materials from sources other than reactor by-products.

D.13.1 Background

The *National Institutes of Health Radiation Safety Guide* provides guidance and technical information concerning the use of radioactive materials as well as policies and procedures for radiation producing machines and areas. Radiation safety control, containment, and shielding design and vivarium practices have been developed to minimize the potential for radiation exposure to workers as well as release to the environment.

D.13.2Specific Areas of Concern

The following key radiation issues were identified relative to vivarium activities:

- radiation safety requirements for vivarium facilities using radionuclides
- radioactive airborne and liquid effluent sampling
- radiation safety requirements for devices used in medical research such a X-rays, accelerators, and irradiators
- radiation safety requirements for nonionizing radiation (only including magnetic resource imaging (MRI) and high intensity lasers (e.g., CO_2))
- security of radioactive materials

All radioactive materials stored at any NIH facility shall be secured, i.e., unattended areas in which radionuclides are in use or stored must be locked or radioactive materials must be locked in containers, refrigerators, or freezers. In addition, besides locked doors, other security options may be implemented, e.g., card key access, etc.

D.13.3 Radioactive Waste Storage

On-Campus Buildings: Vivarium buildings on the NIH campus shall be designed with a separate area for temporary staging of hazardous and radioactive waste. Mixed waste (hazardous waste that is also radioactive) shall be treated as radioactive waste in this temporary staging area. These staging areas are discussed in detail in Hazardous Waste Storage section D.14.4 of these guidelines. Only the specific issues which are directly related to radioactive waste are discussed here.

Information on the carts and equipment for the transfer of radioactive waste currently in use can be obtained from the NIH Division of Safety, Radiation Safety Branch.

The staging area shall be large enough to provide for temporary storage of the radioactive waste and capacity for storage of specialized carts used to transport the radioactive waste from the individual modules. The staging area shall be designed to contain any spills of a radioactive waste that may occur due to handling of the waste materials. It is anticipated that this will be accomplished using specialized carts; however, the Designer may propose alternate means for spill containment.

Special consideration must be given to this area in the fire protection design as indicated in NRC Information Notice 90-09, which specifies the description of the fire protection and suppression system to minimize the likelihood and extent of fire.

Coolers and/or walk-in freezers used to store medical pathological waste will also be used to store animal carcasses, tissues, and bedding contaminated with radioactive materials. Coolers and/or walk-in freezers shall be located in each building.

Module Requirements: All vivarium modules shall be designed for the safe storage of radioactive waste. The volume of radioactive waste generated is a function of the type of work being performed. Thus, the Designer must consider the function of the module to determine the space necessary for radioactive waste storage. The Designer must also recognize that some types of radioactive waste will require segregation from other types and design the radioactive waste storage area to accommodate multiple containers.

All vivarium modules shall be designed to fit the appropriate low-level radioactive waste (LLRW) storage receptacles and/or containers. The NIH Division of Safety, Radiation Safety Branch, shall be contacted for specifications on these containers. Five LLRW streams have been identified for laboratories from the *NIH Waste Disposal Calendar,* as amended in 1995.

- Liquids

    - aqueous waste
    - solvents/other hazardous chemical constituents (mixed waste)

- dry or solid waste (dry active waste)

  - disposable labware
  - sharps (categorized as MPW if not contaminated with radioactive material)

- liquid scintillation vials and/or bulk liquid scintillation media

- animal carcasses and/or tissues

- animal bedding and/or solid excrete

The size of the space dedicated to these of the containers shall be based upon the volume of radioactive materials generated and/or research activities. Standard-sized containers are available from the Radiation Safety Branch and the radioactive waste contractor and should be considered in the design.

The location of the radioactive waste storage in modules shall be standardized to assist emergency response personnel. It is recommended that this storage be located near the door for convenient access by the technician collecting the radioactive waste. For modules with a service corridor, it is recommended that this storage be located near the service entrance rather than the hall entrance. This will avoid the need to move radioactive waste through the main corridors of the building.

The configuration of the radioactive waste storage area in the module shall be designed to facilitate radioactive material spill cleanup and decontamination. Interior surfaces of the storage area shall be readily cleanable for ease in decontamination.

The Designer shall also include the following considerations in the design:

- All modules must have the ability to be locked against unauthorized access

- All radioactive materials shall be secured when unattended

- The space required for shielding the waste containers shall be considered

- Modules and marshaling areas should be sized appropriately to reduce accumulation

- Appropriate spill containment shall be included in all storage areas

- Potential shielding requirements between adjoining or adjacent lab bench areas for high-energy beta emitter radionuclides shall be considered

- If the module is to be used for higher-energy gamma emitter radionuclides, then the design of the countertops and hoods should take into account and compensate for the additional weight required for the appropriate lead shielding

- Secure equipment alcoves should be considered for storage of radioactive materials and/or irradiator equipment

- If there is a need to store radioactive materials in refrigerators and/or freezers, the design specifications should include security provisions, e.g., locks as part of the integrated system, to secure this equipment

- Corridors and public space shall not be designated and used for storage, and equipment such as refrigerators and freezers shall not be designated to store this material in these areas

D.13.4 Module Requirements

Beta barriers for shielding energetic beta emitters (P-32), often transparent plastic (lucite) sheets, 0.95 to 1.27 cm thick, should be considered to protect personnel working in adjacent and close proximity work areas.

D.13.5 Clearance for Renovation/Remodeling

The NIH Division of Safety, Radiation Safety Branch, shall be notified prior to any renovation or remodeling in vivaria using radioactive material. The module shall be surveyed by the Principal Investigator or authorized users, and the Radiation Safety Branch will conduct additional confirmation or clearance surveys

prior to release of the module for unrestricted use, if necessary.

D.13.6 HVAC Systems

Ventilation systems used for controlling airborne radioactive discharges require design considerations. Hoods used for bulking radioactive material shall be designed for ease of sampling. Architects/Engineers should consult with radiation protection personnel regarding methodologies used for sampling. In addition, the design should also accommodate space in the mechanical room to provide for any future additional filtration capability.

If the facility requires additional hoods, specifically for the use of iodination techniques, then the exhaust from these installations shall be equipped with the capability for HEPA or charcoal filtration. A distinct installation should be considered, separate from the main exhaust system.

Filter housings shall be designed for easy filter replacement in order to minimize the possibility of maintenance worker contamination and to provide for easy disposal.

D.13.7 Radioactive Airborne and Liquid Effluent Discharges

NIH design guidance and policy prohibits discharge of radioactive material into sinks. Provision should be made for installation of appropriate sampling probes for sampling capability to assess airborne and liquid effluent discharge streams, including main exhaust systems, sufficient to demonstrate compliance with the requirements of 10 CFR 20.1302.

Liquid effluent monitoring can be accomplished by batch, composite, or continuous sampling prior to discharge into the sanitary sewer system.

The design and construction considerations for airborne radioactive effluent monitoring should also include the following.

- All systems for use with radioactive materials should have the capacity to sample the airborne effluent being discharged, primarily gases and vapors

- Sufficient capacity should be provided for sampling the combined discharge, specifically gases and vapors at a common point located inside the mechanical room downstream of the filters and fans

- Where iodination is performed in specific laboratories, those hoods shall be equipped to accept appropriate HEPA and charcoal filters

- Airborne radioactive effluent monitoring systems should be designed in accordance with ANSI Standard N13.1, Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities (1969), specifically Appendix A, Guides for Sampling from Ducts and Stacks

- A single-nozzle sample probe should be designed inside the air stream for gas and vapors sampling, as specified in ANSI Standard N13.1**.**

Vivarium design considerations should also include state-of-the-art design considerations, as specified by ANSI and other acceptable industry standards, such as

- National Council on Radiation Protection and Measurement (NCRP), Report No. 59, *Operational Radiation Safety Program*, Chapter 3, November 1, 1980

- Hanson and Blatz, *Radiation Hygiene Handbook*, Section 9, Facility Design, 1959

Epoxy coatings, laminates, floor coverings, and protective coatings should be utilized for ease of decontamination and to provide a protective coating which can be readily removed without extensive damage to the existing facility and surfaces.

Sinks should be either plastic composite or coated with epoxy or equivalent to ease the decontamination of surfaces.

Stainless steel is also an option for sinks; however, soapstone shall not be used.

Air filtration systems (activated charcoal/HEPA filtration) shall be

installed and tested in accordance with ANSI/American Society of Mechanical Engineers N510-1980, Testing of Nuclear Air Cleaning Systems.

The activated charcoal and HEPA filters shall be tested with current state-of-the-art methods and techniques for filter efficiency and compliance with technical specifications at the factory and post-installation at NIH facilities.

Chemical fume hoods for radionuclide use should be designed in accordance with the following industry criteria and technical specifications:

- Landis and GYR Powers, Inc., *Laboratory Control and Safety Solutions Application Guide*, 1993

- American Conference Governmental Industrial Hygienists, *Industrial Ventilation: A Manual of Recommended Practice, (current edition)*

- Hoods should have a minimum face velocity of 0.51 linear m/s.

A typical chemical fume hood designed for hazardous materials is acceptable as a radioisotope fume hood. The hood design should include smooth, nonporous surfaces for ease of decontamination. In addition, the fume hood should be constructed of materials that will not generate mixed waste, if the surfaces and the construction materials interact with the radioactive materials.

D.13.8 Vacuum Systems

Vacuum systems should be protected with appropriate filtration (0.3 micron hydrophobic filter or equivalent) to minimize the potential for contamination of vacuum pumps. Filters shall be on the suction side of the pumps, with exhaust to the outside of the facility and not recirculated into the mechanical spaces.

Filters should be located as close as possible to the module in order to minimize the potential contamination of vacuum lines and to preclude and minimize decontamination and decommissioning

costs.

Filter housings shall be designed for easy filter replacement in order to minimize the possibility of maintenance worker contamination and to provide for easy disposal.

D.13.9 Irradiators Utilized in Medical Research

Nonionizing Radiation:

This section applies only to MRI and high-power intensity lasers.

With respect to the use of MRI devices the following regulations and design considerations apply:

- U.S Food and Drug Administration (FDA) regulations, 21 CFR 892.1000, Magnetic Resonance Imaging
- Security requirements for housing and enclosing the equipment
- Warning placards, signs, and postings, which may also include barriers
- Warning requirements for cardiac pacemakers as well as other prosthetic devices and/or equipment
- Shielding requirements to minimize radiation exposure to electric and magnetic fields
- Posting concerning electrical hazards

With respect to the use of lasers, specifically high-power intensity lasers, the following regulations and design considerations apply:

- FDA regulations, 21 CFR 1040, Performance Standards for Light-Emitting Products
- ANSI Standard for the Use of Lasers, ANSI Standard 2136.1, 1986

- *Suggested State Regulations for Control of Radiation, Volume II: NonIonizing Radiation* (8th edition), June 1990

- security requirements for housing and enclosing the equipment

- warning placards, signs, and postings, which may also include barriers

- appropriate personal protective equipment warnings prior to entering and/or working with the equipment to mitigate and prevent eye and skin exposure

A Class III laser system is a medium-pulse system requiring control measures to prevent viewing of the direct beam. Design and control measurers emphasize preventing direct access to the primary or reflected beam. Safety eyewear is necessary and required with this class laser.

High-power intensity lasers (e.g., CO_2 lasers) are classified as Class IV lasers in 21 CFR 1040. These lasers produce radiation so powerful that they can cause injury with a direct or reflected exposure, even when the beam is scattered or diffused by a rough surface or smoke scenes.

Laser facilities should be designed to minimize the use of reflective/refractive surfaces to provide additional protection to occupational workers

D.14 Environmental Management

This section of the describes the general requirements and specific goals for managing environmental issues on the NIH campus. Specific issues that are addressed include

- hazardous materials storage and handling
- hazardous waste storage and handling
- bulk storage facilities
- wastewater discharges
- solid waste management and recycling
- site assessments and demolition

Attention to environmental management issues and proper waste handling are key portions of the NIH's overall goals of ensuring the health and well-being of NIH employees, visitors, and neighbors and maintaining the NIH campus atmosphere.

D.14.1 Background

These guidelines regarding environmental management on the NIH campus encompass the current Federal and State of Maryland regulations regarding environmental management issues. They also include the requirements of local governments and agencies such as the Washington Suburban Sanitary Commission (WSSC) and Montgomery County, Maryland.

Federal laws applicable to environmental management on the NIH campus include

- the Resource Conservation and Recovery Act
- the Clean Water Act
- the Safe Drinking Water Act
- the Clean Air Act

- the Hazardous Materials Transportation Act

Certain environmental issues have been purposely excluded from this section of the Guidelines because they are fully addressed in section G, Site/Civil, of the Reference Materials. These issues include stormwater management and sediment control, erosion control, wetlands, and the use of fertilizers and pesticides in landscaping and groundskeeping.

The requirements contained in these guidelines upgrade the previous NIH design policy and guidelines, which contained little discussion of environmental protection issues.

D.14.2 Hazardous Substance Storage and Handling

All NIH animal care facilities shall be designed to minimize the use of hazardous substances. Alternative nonhazardous or nontoxic materials shall be preferred in all new construction and renovations. The Designer shall develop a plan for eliminating the use of hazardous substances. Where hazardous substance use is unavoidable, the Designer shall demonstrate that alternate nonhazardous substances are either not available, inferior to the hazardous substance, or cost prohibitive. Examples of hazardous substances that should be avoided include, but are not limited to: oil-based paints and caulks; hazardous cleaning, surface preparation, and paint-stripping solvents; and petroleum-based contact adhesives.

In general, most new construction will result in the release (off-gassing) of odors that can affect occupant comfort. If hazardous substances are avoided in the construction, these odors will generally be nonhazardous; however, they can still have a detrimental effect on indoor air quality. Examples of nonhazardous substances that can affect indoor air quality include systems furniture, carpets, and latex paints.

New facilities shall be allowed to off-gas prior to occupancy. Ventilation systems on new construction should be operated for at least 1 month before the building is occupied. For renovations, where it is not feasible to isolate the NIH employees from the off-gassing, materials which are going to off-gas and affect indoor air quality should be allowed to air out and off-gas in a warehouse or

well-ventilated, unoccupied area before they are installed.

Insecticidal dusts, such as boric acid, shall not be applied in wall voids and chase areas as part of facility construction or renovation.

D.14.3 Hazardous Substances Storage

Hazardous substances used at NIH vivarium facilities are substances used in support facility. An example, chemicals are used in animal care facilities for cage washing and neutralization of wastewater discharges.

These materials will be placed in a hazardous substance storage area. In general, these materials are received in 220 L drums or larger. Storage capability should exist in these buildings for up to 10 drums. Some wastewater neutralization chemicals may be stored in bulk containers up to 1,600 L.

Each building utilizing these hazardous substances shall be designed with a receiving and storage area. This area should be located at or near the point of use of the materials and will be used for long-term storage of hazardous materials.

Hazardous substance storage areas shall be out of the normal flow of personnel traffic. There shall be convenient access from the storage area to the freight elevator and or the loading dock without having to use heavily traveled corridors.

The storage area shall be large enough to provide storage of the hazardous substances and room for loading and unloading the drums or containers. If multiple substances will be stored, the design shall allow for incompatible materials to be segregated while in storage.

The storage area shall be designed to contain any spills of hazardous substances that may occur due to handling. Spill containment may be accomplished with a curb around the area, secondary containment bins, shelving designed to contain spills, or a combination thereof.

A chemical-resistant coating shall be applied to the walls and floor in this area to make it easier to clean up spills. All wall and floor penetrations must be sealed to prevent pest harborage

Safety equipment shall be provided for each storage area. This safety equipment shall consist of an emergency eyewash and an emergency shower. Special consideration must be given to this area in the fire protection design if flammable materials will be stored.

D.14.4 Hazardous Waste Storage and Handling

Vivarium buildings shall be designed with a room for temporary storage of hazardous waste and radioactive wastes. Mixed waste (hazardous waste that is also radioactive) shall be treated as radioactive waste in this temporary storage area. Hazardous waste is generally stored in this room for several hours, although it may be stored overnight.

The room shall consist of two individual sections: one for the hazardous waste and the other for the radioactive wastes. The storage room shall be large enough to provide for temporary storage of the hazardous waste and radioactive waste and room for storage of a specialized carts used to transport the hazardous waste from the laboratories. The hazardous waste storage segment shall be at least 2.5 m by 3.5 m. The radioactive waste storage segment shall be at least 0.75 m by 1.5 m. Facilities which generate larger amounts of hazardous or radioactive waste will need larger spaces.

There shall be at least three 2 m high storage cabinets in each room to provide segregated storage of incompatible materials. There shall be sufficient open floor space in the storage room to accommodate one 1 m long waste cart while allowing a person to access the storage cabinets and shelving.

The storage room shall be designed to contain any spills of hazardous waste that may occur due to handling or mishandling of the waste materials. The waste materials will normally be transported using specialized carts which will provide spill containment. The Designer may propose alternate means for spill containment within the storage room. Options may include a spill containment curb around the room and shelving or bins designed

to contain spilled materials. A chemical-resistant coating shall be applied to the walls and floor in this area to make it easier to clean up spills.

The storage room shall be located near the loading dock for easy access to the trucks that will be used to transport the waste to Building 21 for processing. Personnel shall be prohibited from any processing of the hazardous wastes, such as bulking or lab packing, in this storage room.

There shall be convenient access from the storage room to the freight elevator without having to use heavily traveled corridors. This will allow the contractor collecting the waste to bring the waste down from the laboratories to the storage room while minimizing the risks to the building occupants.

A separate ventilation system shall be installed for the storage room. Exhaust shall be directed away from the building and suurounding buildings air intakes. This ventilation system shall be connected to the building's emergency power system. Standard illumination requirements exist for this room. The room shall be designed to fire protection Hazard Group 2.

Safety equipment shall be provided for each storage room. This safety equipment shall consist of an emergency eyewash and an emergency shower.

The NIH Division of Safety shall review and provide final approval of the design of all hazardous waste storage rooms.

D.14.5 Bulk Storage Facilities

Above-Ground Storage Tanks: Wherever possible, the Designer shall consider the use of clean-burning fuels such as natural gas or liquid propane. If storage of these fuels is required, for example a day tank to ensure uninterrupted availability of fuel, it shall be in above-ground storage tanks installed in accordance with State of Maryland and Montgomery County, Maryland, requirements.

All above-ground storage tanks shall be double walled, be provided with secondary spill containment, and shall meet the requirements of the American Petroleum Institute and the National Fire

Protection Association (NFPA). The tanks shall also be consistent with the NIH Spill Prevention, Control, and Countermeasures Plan.

Design considerations regarding the above-ground storage tanks include the location of the tanks to provide access for delivery trucks. At the same time, the tanks should be sufficiently isolated and protected from traffic flow to minimize the risk of accident. The tanks should also be placed in a location to minimize the aesthetic impact of the tank on the surroundings. This would include the use of berms and landscaping to block the view of the tanks.

Spill Control: All bulk storage facilities and above-ground storage tanks shall be equipped with secondary containment to prevent discharge of the material in the event of a spill or a leak. For single storage tanks, the secondary containment shall be large enough to contain the volume of the tank and rainfall from the 10-year, 24-hour storm. For multiple storage tanks, the secondary containment shall be large enough to contain the volume of the largest tank and rainfall from the 10- year, 24-hour storm.

Materials used to provide the secondary containment shall be impervious to the substance contained in the storage tank. The containments shall be equipped with a normally closed valve to prevent accidental discharge of the substance from the containment. This valve can be manually opened to discharge accumulated rainwater after it has been determined that the water is not contaminated.

The other potential spill areas for hazardous substances on the campus are the loading docks. Spills can occur at the loading docks during the loading and unloading of hazardous substances or hazardous wastes.

Loading docks shall be designed to contain spills of hazardous substances and minimize the contamination of stormwater runoff. One option that would accomplish this objective would consist of a loading dock with a grate drain at the base that would accumulate any spilled substances. This drain would be equipped with a normally closed valve to prevent accidental discharge of spilled substances. Uncontaminated runoff would be diverted from this drain by a second grate drain and a small berm. An overhang would

divert direct rainfall from the base of the loading dock to the uncontaminated runoff drain. Alternative designs which meet this objective may be proposed by the Designer.

Control of stormwater runoff and water quality around the NIH campus are discussed in section G, Site/Civil, of the Reference Materials. To ensure proper water quality, all drainage systems which collect runoff from the parking areas shall be equipped with oil water separators.

D.14.6 Wastewater

Wastewater Discharge: Only uncontaminated stormwater runoff shall be discharged from the NIH campus to the receiving stream. All wastewater generated on the NIH campus shall be discharged to the sanitary sewer. Wastewater generated on the NIH campus include domestic sewage from the lavatory facilities, nonhazardous waste discharged from sinks, waters used for cage washing and animal care, waters used in cafeteria operations, and all floor drains.

Wastewater Sampling: The NIH campus is connected to the WSSC sanitary sewer system. The NIH is permitted to discharge wastewater to the WSSC system through a Discharge Authorization Permit. Under the terms of this permit, the NIH must sample its wastewater four times every 6 months and submit an Industrial User Effluent Compliance Permit report to WSSC twice per year.

The wastewater sampling is conducted at the two locations where the NIH sewers connect to the WSSC system. However, for new animal care facility construction, the sanitary system shall be designed to allow for sampling at the discharge point from the individual building. This will allow for testing and troubleshooting of individual building wastewater streams.

The sampling point shall be designed to allow for installation of a continuous pH monitor, installation of a programmable sampler, and personnel access for grab sampling. Cage washing facilities shall be provided with a continuous pH monitor and recorder.

Wastewater Treatment: Since the NIH utilizes the WSSC system, it is normally not necessary to perform wastewater treatment on campus. However, it may be necessary to provide neutralization and equalization of wastewater streams from animal care buildings to comply with WSSC requirements.

In general, the sanitary system for new animal care buildings shall be equipped with an equalization or neutralization tank. Tanks used for equalization and neutralization of wastewater can accumulate sludges and hazardous wastes, require maintenance, and cause odor problems. Therefore, the Designer shall characterize the potential wastewater stream based upon this proposed use. Equalization and neutralization tanks shall be included in new construction if the anticipated characteristics of the wastewater stream indicate that these facilities are likely to be required.

D.14.7 Solid Waste

Waste Minimization: All animal care facilities at the NIH shall adhere to the Environmental Protection Agency's solid waste management hierarchy, which encourages reduction of waste at the source. This hierarchy emphasizes waste minimization as the first step in sound solid waste management. The utilization of reusable products which also has the effect of reducing the overall solid waste stream is also encouraged. Waste products that can not be reused should be investigated to determine if they can be recycled. Only those products that can not be reused or recycled should enter the waste stream for energy recovery or landfilling.

In general, solid waste management is an operational function. However, the requirements for environmentally friendly solid waste management must be included in the design of new construction in order for the solid waste management system to be efficient and convenience to use. Ease and convenience are keys to implementation of a successful solid waste management program. All facilities shall be designed with modern and sanitary waste compaction equipment. This equipment should minimize spillage of wastes and debris and thus the attraction of pests.

Recycling: The NIH campus has an active solid waste recycling program. The program is administered by the Office of Research Services (ORS). This program is described in the draft NIH document Recyclable Blueprint for NIH, dated March 4, 1995. This program establishes white office paper, baled corrugated cartons (BCC), aluminum cans, and polypropylene as primary recycling materials. Mixed paper, wood pallets, scrap metal, polystyrene, food and beverage containers, and yard waste are designated as secondary recyclable materials.

All new construction on the NIH campus shall be designed to be recycling friendly. This consists of placing recyclable collection containers at convenient locations throughout the building to make it easy for NIH employees to accumulate recyclable materials. The selection of recyclables to be collected; the type, size, and number of collection containers; and the locations for the collection containers must be selected by the Designer based upon the planned use of the new facility. For example, more emphasis would be placed on collecting white office paper in an office building than an animal care facility. The designer shall coordinate this selection with the ORS, Division of Safety, Environmental Protection Branch.

Support facilities for recycling must also be included in all new construction. These support facilities would include space in the loading dock for storage of recyclable materials. Paper products, particularly white paper and BCC, must be kept clean and dry to maintain market value and stored in a way to not attract pests or offer them harborage. These require either a room for storage or an enclosed container. Sufficient container space will also be required for the other recyclable materials. Multicompartment recycling roll-off containers are commercially available and may be used for recyclable storage and transportation.

The Designer may want to consider installation of a baler at facilities which are expected to generate sufficient amounts of BCC. A can flattener should be considered for any facility expected to generate sufficient aluminum cans.

The selection of the recycling support facilities and equipment required for all new construction shall be made by the Designer in coordination with the ORS, Division of Safety, Environmental

Protection Branch. Potential options for the loading dock design have been developed by ORS, Division of Safety, Environmental Protection Branch, and can be used as guidelines by the Designer.

Hazardous Waste: All hazardous waste generated on the NIH campus shall be handled in accordance with NIH's generator and TSD permits. Generally, this requires accumulation of the waste at the generation point, temporary (1 day or less) staging at the building loading dock, and transportation to Building 21 for processing. Any facility which can not meet this format shall be considered a special exception to these guidelines. The Designer shall develop the solid and hazardous waste design for this building in consultation with the ORS, Division of Fire Protection.

Demolition:

Site Assessments: Prior to the demolition of any facility on the NIH campus, the Designer shall have a site assessment performed by a qualified environmental engineer. The purpose of the site assessment will be to identify any environmental site hazards that could result in the release of hazardous substances during the demolition or new construction. Potential hazards that must be addressed include possible asbestos-containing building material(ACBM), lead paint, underground storage tanks, hazardous substance storage areas, and spills of hazardous substances.

This site assessment shall include a review of records regarding the design, construction, and use of the building to be demolished and the site; a review of records regarding responses to hazardous substances pill incidents or other emergencies; visual inspection of the building and site; and sampling and analysis of suspect materials are areas to provide quantitative data to backup the qualitative assessment.

Recycling of Demolition Debris:Prior to mobilization on the site, the demolition contractor shall be required to submit to the ORS, Division of Safety, a waste disposal and recycling plan for the demolition activity. This plan shall identify each type of waste material that will be generated by the demolition. The wastes shall be classified as hazardous waste, general waste, or recyclable waste. The alternatives for disposal or recycling of each type of waste material shall be discussed in the plan, with the objective of

recycling as much of the demolition materials as possible.
For any material that will not be recycled, the contractor shall be required to document in the plan, to the satisfaction of the ORS, Division of Safety, why recycling is not feasible. During the demolition activities the contractor shall be required, on a monthly basis, to report to the ORS, Division of Safety, on the status of the recycling activities. This will include weigh tickets or other forms of proof that the specified materials have been recycled. Payments to the contractor shall not be approved unless this documentation has been provided and the contractor is performing in accordance with the approved waste management and recycling plan.

The contractor shall also be responsible for completing and delivering to the Division of Safety, Environmental Protection Branch, of the following forms:

•Contract Recycled Material Notification Form
•Exempt Recyclable Material Mainfest
•Nonhazardous Recyclable Material Manifest

Copies of these forms are attached.

Any wastes generated during the demolition that are designated as hazardous wastes or that require special waste-handling procedures (e.g., asbestos waste) shall be properly handled, transported, and disposed of by the demolition contractor. All manifests, certificates of disposal, and other documentation of proper handling and disposal shall be provided to the ORS, Division of Safety.

Contract Recycled Material Notification Form

Project Title:	
Location of Project:	
Contract Number:	
NIH Project Officer (Name and Phone):	
NIH Contract Officer (Name and Phone):	
Name of Contractor (Company, Contact Person and Contact Person Phone #):	
Sub Contractors (Attach List if Necessary):	
Types of Materials Anticipated To Be Recycled: (Building materials includes items intended for reuse, provide a description of Otherî)	____Ferrous scrap metal ____Nonferrous scrap metal ____ Concrete/asphalt ____ Glass ____ Insulation ____Plastics ____Building materials ____ Electrical Wire/Cable ____ Wood ____ Other

The above information should be forwarded to the NIH Division of Safety, Environmental Protection Branch (EPB), (Bldg. 13/Rm. 2W64, NIH) if recyclable materials will be removed under this contract. A recyclable material manifest, either nonhazardous or exempt, shall be prepared for each shipment of recyclable materials. Any manifest for shipments of exempt hazardous materials (e.g., scrap metal with lead paint) should be forwarded to the EPB 3 days prior to shipment for approval and will be signed by an EPB representative on the shipping day. The Contractor shall forward to EPB, completed copies of all shipping documents together with weight tickets signed and dated by the Contractor in verification of their accuracy within 30 days of the shipping date.

The Exempt Recyclable Material Manifest will be used for scrap metal which contains hazardous waste constituents, as an inherent component or external coating, but is still acceptable to a recycling outlet. The Nonhazardous Recyclable Material Manifest will be used for any nonhazardous waste which is being recycled, such as. concrete, glass, electrical wire, etc. Please note that any material which is contaminated with hazardous waste and is **not** scrap metal and is acceptable at a recycling facility must be shipped as hazardous waste using a hazardous waste manifest signed and approved by the EPB.

Name:_____
Signature_____Date: _____
DES, NIH Project Officer

Name:_____
Signature_____Date: _____
DES, Contractor Contact Person

Name:_____
Signature_____Date:_____

Revised 10/26/95Chief, Environmental Protection Branch Representative

Revised 10/26/95Manifest No. __ __ __ __ __

EXEMPT RECYCLABLE MATERIAL MANIFEST

GeneratorName_____
Address_____
PhoneNo. ___(_____)_____

GeneratingLocation _____
Address _____
PhoneNo.___(_____)_____

	Description of Waste	Net Weight	Units
Container Type	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Container Type	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Container Type	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

It is certified that the scrap metal described above is a recyclable material as defined in Title 40 CFR 261.6 (a)(1) and COMAR 26.13.02.06. This shipment to a facility for reclamation does not require a Uniform Hazardous Waste Manifest, disposal at an EPA-or-State permitted facility, or compliance with other hazardous waste requirements for Title 40 CFR 262-266 or Parts 268-270 or 124 and Maryland State Regulation COMAR 26.13.03.07. This material has been properly described, classified, and packaged and is in proper condition for transportation according to applicable regulations.

_____ _____

Generator Name (NIH Representative) Signature Shipping Date

Truck/Container No._____
Phone No. _____

Transport Co. _____

Driver Name _____

Address_____
VehicleLicense#_____
Vehicle Certification _____

I hereby certify that the above-named material was picked up at the generator site listed above.

I hereby certify that the named material was delivered without incident to the destination listed below.

Comments_____
_____
_____

_____ _____
Signature Ship Date Signature Delivery Date

Site Name _____
PhoneNo. _____

EPA Generator ID No. (if waste is not inherently hazardous) _____
Address _____
Comments_____
_____
_____

I hereby certify that the above-named material has been accepted and that to the best of my knowledge the foregoing is true and accurate.

_____ _____ _____
Recycling Facility Representative Signature Shipping Date

RECYCLING FACILITY: Please attach a copy of the weight ticket to a copy of this manifest and return to the Generator at the above address.

Revised 10/26/95
Manifest No. __ __ __ __ __

NONHAZARDOUS RECYCLABLE MATERIAL MANIFEST

GENERATOR

Generator Name _____
Address _____
Phone No. ___(_____)_____
Generating Location _____
Address _____
Phone No.___(_____)_____

Description of Waste	Net Weight	Units	Container Type
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

It is certified that the material described above does not contain free liquid as defined by 40 CFR Part 260.10 or any applicable State law and is not a hazardous waste as defined by 40 CFR Part 261 or any applicable State law. This material has been properly described, classified, and packaged and is in proper condition for transportation according to applicable regulations.

_____ _____ _____
Generator Name (NIH Representative) Signature Shipping Date

Truck/Container No._____
PhoneNo._____

Transport Co. _____
Driver Name _____

Address _____
Vehicle License #_____
Vehicle Certification _____

I hereby certify that the above named material was picked up at I hereby certify that the named material was delivered without

the generator site listed above.incident to the destination listed below.

Comments
_____

_____ _____
Signature Ship Date Signature Delivery Date

DESTINATION

Site Name _____
Phone No. _____

Address _____
Comments _____

I hereby certify that the above named material has been accepted and that to the best of my knowledge the foregoing is true and accurate.

_____ _____
Recycling Facilities Representative Signature Shipping Date

RECYCLING FACILITY: Please attach a copy of the weight ticket to a copy of this manifest and return to the Generator at the above address.

D.15 Fire Safety/Fire Protection

This fire protection section includes specific requirements for vivarium facilities. The general fire protection requirements are found in Section H - Reference Materials.

Automatic Sprinkler Systems: All sprinkler system designs shall meet, at a minimum, NFPA 13 Ordinary Hazard Group II spacing and hydraulic requirements.

Sprinklers in the vicinity of the animal areas are to be the institutional/quick response type.

Upright sprinklers shall be installed in areas with ceiling heights of 2.44 meters or less.

Fire Protective Signaling Systems: A fire alarm voice communication system shall be provided in the animal holding/procedure areas. Upon an alarm, the fire alarm speakers are to sound a "slow-whoop" signal, at 90 - 110 dB, for one cycle (4.1 seconds), followed by a repeating voice evacuation message. The voice message in this area shall continue until the fire alarm control panel is reset or the "alarm silence" switch is activated.

Duct Smoke Detection: Duct smoke detectors shall not be installed in air handling units of less than 425 m3/min, in air handling units which serve only one fire area, or in fully sprinklered buildings. Installed duct smoke detectors (photoelectric type) shall be connected to the building fire alarm system, and shall result in automatic air handler shutdown.

D.16 Pest Management

The risk of potential contamination and disease among study animals by pathogens carried by pests and vermin is ever present. The only effective pest control, program is strict prevention of infestations. Above all else, maintaining a clean, sanitary facility at all times will minimize food sources and breeding areas for most vermin. All penetrations, cracks, voids, and gaps in room enclosures should be sealed and caulked. The vivarium must also be made secure from external pests via introduction of barriers (air curtains, vestibules, etc.) at entries and exits.

Exterior windowsills should be avoided to discourage bird nesting or roosting.

The Architect/Engineer should ensure that areas of pest ingress, such as doors, windows, loading docks, etc., are fitted with appropriate exclusion devices. Consideration should also be given to designs that minimize creation of pest harborage and promote proper cleaning. Examples of harborages are inaccessible voids behind and under equipment and casework, unsealable cracks or joints between equipment of finish materials, or the use of unsealed foam or fiberglass insulation on pipes and equipment.

The NIH Division of Safety, Pest Management Unit, should be consulted to review and approve all plans for new construction and renovation of old space.